

**In the Claims**

1. - 43. (Cancelled)

44. (previously presented) An X-ray inspection system which incorporates a detector which relies on the electro-magnetic cascade effect produced in suitable materials when bombarded with X-rays so that energy is transferred into the material at different depths depending on the energy of incident X-rays, wherein the first component on which the X-rays impinge comprises a relatively thin crystal and unwanted background noise is reduced by placing a vessel containing a fluid whose density is less than that of air, in front of the detector crystal array.
45. (previously presented) An X-ray inspection system as claimed in claim 44, wherein the vessel comprises a bag, formed from film transparent to X-rays.
46. (previously presented) An X-ray inspection system as claimed in claim 44, wherein the fluid is helium.
47. (previously presented) An X-ray inspection system as claimed in claim 44, in which the fluid is maintained at atmospheric or slightly greater than atmospheric pressure.
48. (previously presented) An X-ray inspection system as claimed in claim 44, wherein the background is reduced by applying a magnetic field in the region in front of a detector crystal array so as to sweep away electrons from that region.
49. (previously presented) An X-ray inspection system as claimed in claim 44, when used for medical and non-destructive testing purposes.
50. (previously presented) An X-ray inspection system as claimed in claim 44, when used to perform radio therapy, in which X-ray energies in the range 18 to 25 MeV are employed.
51. (previously presented) An X-ray inspection system in which a thin X-ray absorber is placed upstream of an object under investigation so as to remove low energy X-rays.

52. (previously presented) An X-ray inspection system as claimed in claim 51, wherein the absorber removes X-rays below 0.5MeV.
53. (previously presented) An X-ray inspection system as claimed in claim 51, wherein the absorber is a sheet of lead 10mm thick.
54. (previously presented) An X-ray inspection system as claimed in claim 51, wherein the background is reduced by applying a magnetic field in the region in front of a detector crystal array so as to sweep away electrons from that region.
55. (previously presented) An X-ray inspection system as claimed in claim 51, when used for medical and non-destructive testing purposes.
56. (previously presented) An X-ray inspection system as claimed in claim 51, when used to perform radio therapy, in which X-ray energies in the range 18 to 25 MeV are employed.
57. (previously presented) An X-ray inspection system for determining the material composition of an object wherein the detector includes a crystal, and a magnetic field is generated in front of the crystal between the object and the crystal, to deflect stray electrons from the crystal.
58. (previously presented) An X-ray inspection system as claimed in claim 57, when used for medical and non-destructive testing purposes.
59. (previously presented) An X-ray inspection system as claimed in claim 57, when used to perform radio therapy, in which X-ray energies in the range 18 to 25 MeV are employed.
60. (currently amended) A material discrimination detector ~~of the type described in EP 0621959~~  
for x-ray inspection using high energy X-rays in combination with either or both of a vessel containing low density fluid and means for generating a magnetic field, in front of the detector.
61. (previously presented) A material discrimination detector as claimed in claim 60, when used for medical and non-destructive testing purposes.

62. (previously presented) A material discrimination detector as claimed in claim 60, when used to perform radio therapy, in which X-ray energies in the range 18 to 25 MeV are employed.
63. (currently amended) An X-ray material inspection system ~~of the type described in EP 0621959~~ for x-ray inspection using high energy X-rays, wherein electrons and scattered X-rays are removed by positioning at least one collimator in front of the crystal detector.
64. (previously presented) An X-ray material inspection system as claimed in claim 63, wherein a lead collimator is employed.
65. (previously presented) An X-ray inspection system as claimed in claim 63, when used for medical and non-destructive testing purposes.
66. (previously presented) An X-ray inspection system as claimed in claim 63, when used to perform radio therapy, in which X-ray energies in the range 18 to 25 MeV are employed.
67. (previously presented) A material discrimination system in which the first detector component is a thin scintillation crystal which is required to register an amount of energy deposited by an X-ray that is essentially independent of the X-ray MeV energy, wherein a low Z converter is located after this crystal to stop electrons produced by X-ray interactions downstream of the crystal from being significantly back scattered into the front crystal and prevent electrons leaving the front crystal from returning and depositing more energy in the front crystal, and wherein the low-Z converter is situated between the thin front scintillation crystal and a thicker downstream scintillation crystal, and is adapted to reduce the back scatter of electrons into the front crystal and to prevent electrons which have left the front crystal from returning thereto.
68. (previously presented) A material discrimination system as claimed in claim 67, wherein the low Z converter is aluminium.

69. (previously presented) A material discrimination detector for system as claimed in claim 67, when used for medical and non-destructive testing purposes.
70. (previously presented) A material discrimination detector for system as claimed in claim 67, when used to perform radio therapy, in which X-ray energies in the range 18 to 25 MeV are employed.
71. (previously presented) A material discrimination system in which a low-Z converter is located downstream of a first scintillating crystal detector to prevent electrons produced by X-ray interactions downstream of the said first crystal from back scattering into the first crystal and to prevent electrons from leaving the first crystal and returning thereto, and wherein the low-Z converter is situated between the thin front scintillation crystal and a thicker downstream scintillation crystal, and is adapted to reduce the back scatter of electrons into the front crystal and to prevent electrons which have left the front crystal from returning thereto.
72. (previously presented) A material discrimination system as claimed in claim 71, wherein the low Z converter is aluminium.
73. (previously presented) A material discrimination system as claimed in claim 71, wherein behind the low-Z converter is located a high-Z, high density convertor, whose main purpose is to ensure that even the higher MeV energy components of an X-ray beam lose energy at the maximum rate so that the electro-magnetic cascade reaches equilibrium, to ensure that the maximum amount of energy per X-ray is deposited in the following crystal, so that it will respond preferentially to higher energy X-rays.
74. (previously presented) A material discrimination system as claimed in claim 71, when used for medical and non-destructive testing purposes.

75. (previously presented) A material discrimination system as claimed in claim 71, when used to perform radio therapy, in which X-ray energies in the range 18 to 25 MeV are employed.
76. (previously presented) A material discrimination system as claimed in claim 73, where the high-Z material is tungsten.
77. (previously presented) A material discrimination system as claimed in claim 73, wherein electrons travelling backwards out of the said crystal as a result of multiple Coulomb scatter, are absorbed in both the low and high-Z converters so that they are unable to reach the thin front crystal.
78. (previously presented) A material discrimination system as claimed in claim 77, wherein high-Z, high density converters, are interleaved with scintillating crystals.
79. (previously presented) A material discrimination system as claimed in claim 78, wherein each crystal is read out by a pair of photodiodes or pair of fibres.
80. (previously presented) A material discrimination system as claimed in claim 79, wherein signals from all such pairs of read out devices are added which increases the effective energy of the high energy X-ray component that is registered, and hence the magnitude of the material discrimination effect.
81. (previously presented) A material discrimination system as claimed in claim 78, wherein an absorber is located at the rear of the detector assembly, to stop electrons produced by X-rays which carry on downstream and scatter in any structure to the rear of the apparatus, from reaching the rear crystal of the detector array.
82. (previously presented) A material discrimination system as claimed in claim 81, wherein the absorber is aluminium.
83. (currently amended) A material discrimination detector ~~of the type described in European patent 0621959~~ for x-ray inspection using high energy X-rays in which the thin front crystal

is read out from each side as by a photodiode, or fibre, and the outputs from the two opposite sides of the crystal are added, so as to prevent any left/right asymmetry in signal which can result from reading out at one end only, with respect to direction of motion of the object under investigation relative to the detector.

84. (previously presented) A material discrimination detector as claimed in claim 83, when used for medical and non-destructive testing purposes.
85. (previously presented) A material discrimination detector as claimed in claim 83, when used to perform radio therapy, in which X-ray energies in the range 18 to 25 MeV are employed.
86. (previously presented) An X-ray inspection/material discrimination system detector comprising a front thin crystal and a rear thick crystal, wherein the latter is read out by a plurality of photodiodes or fibres or other devices which sample at different depths in the beam direction, and the signals from the different sampling devices are added to represent the high energy X-ray component.
87. (previously presented) A detector as claimed in claim 86, wherein outputs from the two sides of the crystal are combined to prevent left/right asymmetry.
88. (previously presented) A detector as claimed in claim 86, wherein the second crystal is replaced by an alternating sandwich of crystals and high-Z convertors and each of the crystals in the sandwich is read out using two or more read-out devices.
89. (previously presented) A detector as claimed in claim 86, when used for medical and non-destructive testing purposes.
90. (previously presented) A detector as claimed in claim 86, when used to perform radio therapy, in which X-ray energies in the range 18 to 25 MeV are employed.
91. (previously presented) A detector as claimed in claim 88, wherein the outputs from opposite sides are combined to prevent left/right asymmetry.

92. (previously presented) A detector as claimed in claim 91, wherein the crystals are read by fibres leading to CCD cameras or photodiodes and all of the read-outs are combined to produce a signal corresponding to the high energy X-ray component.
93. (currently amended) A material discrimination detector for use in an X-ray discrimination system ~~of the type described in European patent 0621959~~ for x-ray inspection using high energy X-rays wherein the front and rear scintillation crystals are cut from the same ingot of material in order to provide matched performance.
94. (previously presented) A material discrimination detector as claimed in claim 93, when used for medical and non-destructive testing purposes.
95. (previously presented) A material discrimination detector as claimed in claim 93, when used to perform radio therapy, in which X-ray energies in the range 18 to 25 MeV are employed.
96. (previously presented) A detector as claimed in claim 93, wherein the material is CsI and the choice of material is such as to minimise persistence of the signal due to low phosphorescence decay.
97. (currently amended) A material discrimination system ~~of the type described in European patent 0621959~~ for x-ray inspection using high energy X-rays which includes a Linac, and wherein the read-out system is synchronised to the Linac pulse, with one read-out cycle for each pulse, and in which the read-out system also samples the output from crystals between each Linac pulse, so as to provide signals indicative of noise and crystal persistence.
98. (previously presented) A system as claimed in claim 97 wherein the Linac is triggered on each alternate pulse only, and during non-beam read-outs, signals corresponding to background, noise and crystal persistence, are subtracted.
99. (previously presented) A system as claimed in claim 97 wherein the Linac RF functions in the untriggered condition throughout.

100. (previously presented) A system as claimed in claim 97, when used for medical and non-destructive testing purposes.
101. (previously presented) A system as claimed in claim 97, when used to perform radio therapy, in which X-ray energies in the range 18 to 25 MeV are employed.
102. (currently amended) A material discrimination system of the type described in European patent 0621959 for x-ray inspection using high energy X-rays which incorporates a Linac in which the channels are normalised so as to overcome non-linear effects due to saturation, and calibration is performed by increasing the X-ray beam flux by known increments.
103. (previously presented) A system as claimed in claim 102, wherein calibration is performed using a step wedge of absorbing material with increments of thickness chosen to yield fixed decrements of transmission between 90% and 10% when used with a particular Linac.
104. (previously presented) A system as claimed in claim 102, when used for medical and non-destructive testing purposes.
105. (previously presented) A system as claimed in claim 102, when used to perform radio therapy, in which X-ray energies in the range 18 to 25 MeV are employed.
106. (previously presented) A system as claimed in claim 103, wherein the step wedge is formed from PTFE.
107. (previously presented) A method of calibrating a system as claimed in claim 103, involving moving the step wedge across the X-ray beam and determining the average signal value vs. step thickness, for use as a base level for channel to channel normalisation.
108. (previously presented) A method of calibrating a system as claimed in claim 107, wherein the step wedge is formed from PTFE.



109. (previously presented) A method of material discrimination using X-rays which is performed by generating calibration curves of material discrimination effect (MD) verses transmission  $T$ , where  $T$  is 1 for zero absorbtion and 0 for completely absorbing objects, and the MD effect is derived from the lower and high energy signals, and calibration is performed using step wedges of suitable absorbing material.
110. (previously presented) A method of claim 109, wherein a range of curves for calibration is produced using different materials such as PTFE, aluminium, and iron, whereby the effective  $Z$  of an unknown material can then found by comparing its MD effect and  $T$  value with the corresponding values of known materials, and then interpolating.
111. (previously presented) A method of testing for the presence of a material whose effective  $Z$  is different depending on whether high or low energy X-rays are employed, comprising the steps of inspecting an object under test using high energy X-rays and noting the effective  $Z$  of the constituents of the object, inspecting it using low energy Z-rays and noting the effective  $Z$  of its constituents, and comparing the values of  $Z$  obtained from the two tests for the each identified constituent in the object, and using a look-up table of  $Z$  ratios for the two X-ray energies, to assist in determining the identity of each constituent.